2. Project report

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Photovoltaic driven air-conditioning systems worldwide

Abstract

Photovoltaic systems combined with electrical compression chillers offer a high potential for energy efficient cooling with a high economic feasibility. Due to much higher energy efficiency ratios of electric chillers compared to sorption cooling systems, the heat rejection system is much smaller and thus auxiliary energy and water consumption lower than in sorption cooling systems. The overall system efficiency, auxiliary energy consumption and achievable solar fraction depends on the photovoltaic module technology, the compression chiller energy efficiency ratio, the possibility of using DC compressors without inverters and obviously on the temporal correspondence of solar cooling production and cooling demand. A systematic simulation study was carried out using the simulation environment INSEL to evaluate the overall performance of photovoltaic compression cooling systems in office buildings for different climatic conditions worldwide. For each location and cooling demand the photovoltaic energy production for different PV module areas was calculated and solar fractions, COP and auxiliary energy demand was determined. It could be shown that primary energy ratios tend to be lower than for sorption cooling systems. As electrical storage is still too expensive and cold storage has only limited capacity due to small temperature differences photovoltaic cooling is most recommendable for locations with a good temporal coincidence between PV production and demand. The economics of the PV cooling systems were analyzed. The overall economics strongly depend on the feed-in tariff and the other own consumption patterns in the buildings, especially if solar fractions are low. Finally solar thermal cooling was compared to solar electrical cooling. The best options for implementing PV driven compression cooling systems are summarized in the student research project.

Keywords: solar electrical cooling, simulation, INSEL, primary energy savings, COP